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WHAT MATHEMATICAL SUBJECTS SHOULD BE INCLUDED IN THE CURRICULUM OF THE SECONDARY SCHOOLS? FROM THE POINT OF VIEW OF THE INDUSTRIAL ESTABLISHMENTS.

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The most important of all branches of learning is the ability to read. The translation of symbols, figures, letters, words, understandingly and meaningly to the brain by the eye, stands first in importance of "the three R's." The ability to express thoughts in characters or symbols for the edification of others, the art of inscribing such thought or words on paper or parchment—the ability to write, stands second of "the three R's." And then we have arithmetic, the third of "the three R's." Arithmetic, the lowest branch, the primer of mathematics, is the most useful and most applicable of all our branches of mathematics.

From the point of view of an employer of a large number of boys who have attended the public schools of our country, I wish to address my remarks on the assigned subject.

The Santa Fe Railroad a few years ago was suffering from a lack of first-class mechanics. Wages were good, surroundings pleasant, working conditions excellent, and a spirit of uplift everywhere. But there seemed to be no first-class mechanics in the country desiring work. All seemed busy. The management said: "If we can't hire men, we will make them." So with instructions from our vice-president a committee visited all the prominent railroads and manufacturing enterprises in the country, ascertaining what they were doing towards making men. The committee made its report and recommendations and orders were immediately issued to establish an advanced system of educating apprentices, beginning the following month. This duty was assigned the speaker. With no knowledge of the subject and with only our theoretical and practical education, we dived into the work and today we think we have a better sys-

tem of educating apprentices for the trades than any other institution in existence.

We selected first-class, practical mechanics for shop instructors, men who are not only artists in their particular trades, but who are patient, boy-loving leaders, possessed with the faculty and spirit of teaching boys. Each of these men was given twenty-five apprentices in the shop, his sole duty being to teach these boys their chosen trade. The boys were not left to flounder along alone, picking up what they could here and there, thrown entirely upon the mercy of the shop foremen, or the other mechanics, but these instructors were there to start them out the right way, to guide and direct them in every move, teaching them every part of an engine or car or shop tool, and the function of each part, and so on from one department to another until the expiration of the four-year apprenticeship course. Then they were graduated as first-class mechanics, capable of performing any duty or doing any job that should be expected of one versed in their particular trade.

We found, however, that boys coming to us from our public schools were deficient in practical education, making it necessary in addition for our shop instructors to establish what we called our apprentice school, where these apprentice boys were required to assemble a given number of hours each week to study such subjects as we deemed advisable to teach them. In this school room we had to experiment considerably in order to ascertain the exact things that should be taught and how they should be taught. In the first place, we found there were no text-books adaptable to the work and it was incumbent upon us to prepare such books. We adopted a looseleaf system of lesson sheets and thus, having a printer and a press of our own, we have been able to revise and add to these lessons as often as occasion demanded. In the second place, we found the boys were not all endowed with equal ability to learn and it was necessary that instruction be individual rather than in a class. To this individual instruction we attribute our greatest success. We do not attempt to teach them all the subjects or branches taught in the ordinary school but we make it a point to teach them such branches and only such branches as they actually need in their chosen trade, and these robbed of all frills and trimmings.

This school room instruction is given during daylight hours and the boy is paid while attending school the same as if he were actually working in the shop.

The newspapers, without any effort on our part to advertise the scheme, gave it a great deal of publicity. In a very short while, the boys began to come to us faster than we could take them in and at this date we have over a year's supply on our waiting list. Our practical instruction of the boys in the shop has been quite easy, although we experienced some difficulty in getting the right kind of men to act as shop instructors. It only required patience, care, and individual instruction to make each of these boys competent for his particular work.

In our school room work, about the first thing we noted was the deficiency of the boys in mathematics. The boys who had passed through grammar school and who had had one or more terms at high school, were practically unfamiliar with the solution of problems in ordinary common fractions, and at times they seemed hopeless. The majority of them could not add or multiply with any degree of accuracy and in the multiplication and division of decimals they were distressingly ignorant. The few who were familiar with the four fundamental operations of arithmetic were lost when it came to independent thinking. With a little help, some of them did fairly well, but through it all they showed that in their school work their difficult problems had been solved, or at least the solutions had been started by others.

I have realized more than ever before the importance of thoroughness in the elementary schools. In the various trades mathematics is the most useful of our educational branches and arithmetic is the most important, most practical of all mathematics. Of one million computations, twelve will be found to involve higher mathematics such as calculus, geometry, trigonometry, or algebra, but the other 999,988 require arithmetic only, and I believe that 90 per cent. of the men in life today can get along safely in all their mathematical requirements with a well-grounded knowledge of arithmetic. The present method of teaching writing has made a generation of poor penmen. I sometimes wonder if this is not one reason for such poor adders and multipliers and dividers. The careless method of making

figures, some of which the boy himself cannot read a moment after writing, should make us use our most powerful and effective influence in persuading our public schools to teach the pupils to make good, clear, distinct figures. I have noticed in our apprentice system that the boy who is neat and clean in the school room, who keeps his drawing board and paper clean, who makes clear and distinct lines and letters, is a clean, exact, and neat workman in the shop.

The principal of one of your schools in this city some time ago compiled some very interesting figures from the reports issued by the government on education, and I noted that out of one hundred boys entering high school, only seven enter college and of these seven only one is graduated. I do not mention this with any feeling of animosity against the college but I quote him for the simple reason that the ninety-three who cannot go to college demand of you and of me an effort in their behalf. For one hundred years or more the aim of our public schools has been to prepare the boy for college. Now, what about those ninety-three boys who do not go to college? The progressive feeling is alive in many fields other than politics.

A boy came to us one day with a brilliant recommendation from his principal. He had led his class from the primary grade on up through the grammar school and had had one-half term at high school. Examining him as an applicant for apprenticeship, I found his writing very illegible. While his English was good and he was familiar with the men and places of the city, and could converse intelligently on current topics, his ignorance or carelessness in simple arithmetic was truly distressing. Simple problems in addition and subtraction of fractions seemed a heavy load. He spent as much time adding $\frac{1}{4}$, $\frac{1}{2}$, $\frac{7}{64}$, $\frac{3}{8}$, and $\frac{9}{16}$ as you would in eating your dinner, and then he didn't add it up correctly. I will say, however, for this boy that he could tell you very quickly how much $\frac{1}{4}$, $\frac{1}{2}$, $\frac{3}{4}$, and $15\frac{1}{2}$ dollars amounted to; but put the same fractions in inches or ounces or pints, and he was simply lost. This boy had not been taught the real value or science of numbers. I don't care what process, what method, what system you employ, so long as the child is intelligently and understandingly taught. But you know, and I know, that under the present system the fruit is faulty and warrants a change.

I do not fully agree with the German schools in giving all kinds of mathematics to a boy before he finishes high school, for I do not think that the boy's brain is sufficiently aged to reason with the higher mathematics such as analytical geometry and calculus. I am, however, strongly of the opinion that the teachers should enter more closely into the boy's life and should make a strong effort to find out the boy's particular talent and that the course should be sufficiently flexible to allow the teacher to direct the boy along the channels which such investigation demands or requires.

There is no doubt too much class instruction and not enough individual instruction. Because a boy may be deficient or lagging in arithmetic does not necessarily mean that he is a dunce. He may be very proficient in art; he may love history, he may love carpentry. It is the duty and function of the teacher to find out such facts and then proceed along the lines justified by such an investigation. I am a strong believer in the departmental method of teaching mathematics. Let one teacher teach all mathematics above the third grade in the elementary school, just as we now have teachers for mathematics in the high school, and these teachers should be men. While women are very proficient in teaching other studies, my experience, and I have had teachers of all kinds, is that a man can more successfully and more understandingly teach mathematics than a woman. This is one reason, I think, why mathematics is much more interesting after you enter college than when you were attending public school. I believe that the pupil should begin arithmetic in the third grade and continue on through high school, beginning in algebra the last term of the first year in high school, and continuing for a year and a half, then taking up plane geometry for a year, and finally winding up with one term of commercial arithmetic. I do not think the high school should attempt to teach analytical geometry, trigonometry, or even solid geometry. With the exception of one or two of the higher professions the high school mathematics will equip 90 per cent. of our citizens with all the mathematics they need in life. It is all the farmer will ever need; it is all the contractor will ever need; it is all the banker ever uses. Addition seems to be all the lawyer or plumber uses.

My twelve-year old boy a short while ago brought his arith-

metic home one evening for the first time. He had some problems in board measure and these problems had floored him. He wanted me to explain board measure to him. I spent one hour explaining to him what was meant by board measure and by a board foot. I went to our work bench and explained by different sized boards what was meant by this standard of measurement. I also showed him some bills for lumber and how they figured it out and what was meant by \$21.65 per thousand. The text book said a board foot was a piece 1 foot long, 12 inches wide and 1 inch thick. Neither the text book nor the teacher made it plain why or wherefore this standard, nor was it made plain how to proceed if the board was 9 inches wide and 3 inches thick. Now that boy is not a dunce nor a laggard. He is far above the average, receiving perfect marks on ten of his twelve studies, but on this subject he was simply plugging away, blindly trying to get the answer. Now, the schools of Kansas are equal to those in Philadelphia or Boston, if anything, better. They have not been running so very long and their history is short. They are not slow about adopting precedents and have few land marks they hold dear and no sacred customs to keep alive. I am perfectly willing from my experience in dealing with the boys from the grammar schools, to wager my month's salary against the price of a dinner that 75 per cent. of the boys from the eighth grade schools in Philadelphia cannot figure in three minutes how many eggs to give for 20 cents if they are selling for 23 cents a dozen.

I notice in all our arithmetics that the problems generally have an answer in even numbers, while in daily practice there are few problems that come out evenly, few whose solution does not require a ready and thorough knowledge of fractions, and sufficient judgment to know when to drop the fraction, when to approximate its value, and when to carry it in full. Why our text books ignore this, I cannot understand, unless it is a matter of convenience and ease for the teacher and the pupil or to enable the class to skim over more ground.

I like the German idea of teaching, in that the teachers are given some leeway and are not bound alone to the text book but have the privilege of closing the text book for an hour or for a day. The teacher is one who is sufficiently resourceful to add one or a dozen pages and omit the same if circumstances

or discretion calls for it. I believe it would be better if all the mathematics was taught in school and the child not allowed to carry his text book home. There are so few heads of families who can successfully teach mathematics, who can explain the problem or the process sufficiently to make it clear to the boy. Working problems at home, or, as is generally the case, having someone else work them and then handing them in to the teacher may cause the class to move along faster, but it also makes some very stupid mathematicians.

I do not care so much about your text books but I do care about your teachers. The teacher should be sufficiently intelligent and resourceful to invent new problems, to make them so attractive as to interest the child and to make them so fresh and homelike as to keep the child's mind fixed. In nearly every section of the country arithmetic ends with the eighth grade. Now, the average child is just reaching the age in which the beauty of the science of mathematics is dawning upon him, an age at which the use of mathematics is becoming more apparent. In fact, few boys under this age really understand anything about the principle or the science of arithmetic. That is why I urge that arithmetic be continued on, through the high school.

To the great majority of our citizens the struggle for life begins at the age of fifteen. The door of the elementary school has closed for them, the door of the high school opens only to the favored few. The competition for daily bread drives the half grown boys and girls into the market. They take what they find. True, the question of the child's future has peered out of the background in the minds of parents and relatives. Their eyes are fixed on the necessities of the moment. Positions are valued at the salary they offer, however unfavorable the conditions may be for intellectual or moral development. Some few have the force of character to struggle through untoward circumstances. Their intelligence, their will-power, perhaps also their home training, gives them strength to overcome the forces that drag men down. Some few have the good fortune to get into a factory or shop that has a natural interest in well-trained workmen. Some few find employers who do not regard the young hand as a cheap workman but as a human being who must be educated. But the innumerable mass of weaker and less fortunate youths, of whom thousands and thousands are

also valuable human material, and the innumerable mass of real capacity that find no warm-hearted employer and no employment demanding intellect, drift like shipwrecked men on the stormy ocean. Some reach the haven, after a loss of many years; the majority lead a life never brightened by the sun of joy in work. No one has ever taught them to seek the true blessing of work. No one has ever taken the trouble to point them to anything farther ahead than the daily task by which they must earn their bread their whole lives long.

Our present schools are largely like the old school. Years ago we had a rural population and few boys were destined for the professions. We had boys made resourceful and industrious by farm work, boys who were homogeneous sons of American parents, boys zealous for learning in preparation for life's occupations, boys destined for a simply social order, with few occupations and few problems. Today we have cities with a population of all sorts of boys without any occupation, city and town boys who have never performed a single task, children of every nation under heaven, thousands of boys unambitious and purposeless, and a highly complex social order, with innumerable activities and interdependent problems. It is proper for our schools to take these boys and make them the best citizens possible. The revolution of our social and industrial condition makes it more necessary than at any former period of our existence. It is a fair proposition that the school should study its raw material and the kind of a product the market needs and it should endeavor to deliver 100 per cent. marketable goods.

Any boy or girl who can read intelligently, who can write a clean, distinct hand, and who is capable of quickly and correctly performing the four principal functions of arithmetic together with percentage and ratio and proportion, can always get a position. Business men complain continually that the average boy and girl coming to them from our public schools is wholly unable to perform the above functions correctly. Now, since the great majority of such boys and girls must leave school and go to work at the age of fifteen, is it not our duty to so drill, so teach, and so instruct them that they may in a measure be enabled to go out and make a living? It is our duty. It is an obligation for which we are paid and which we owe to the parent and to the commonwealth.